



Stability Measurements for the ATRIUM™ 10XM BWR Fuel Bundle

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FUEL



Presentation Scope



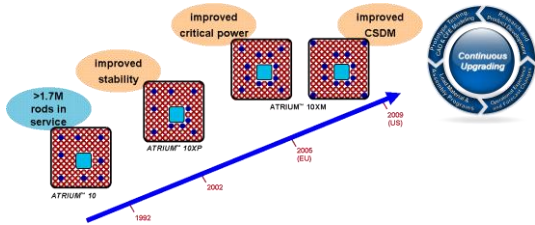
- ▶ ATRIUM™ 10 Design Evolution
- ▶ History of AREVA stability testing at the KATHY Loop
- ▶ Evolution of KATHY Loop to test reactor for ATRIUM™ 10XM
- ▶ Sample test results

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ATRIUM™ 10 Design Evolution & Testing



Experimental program in KATHY Loop motivated by

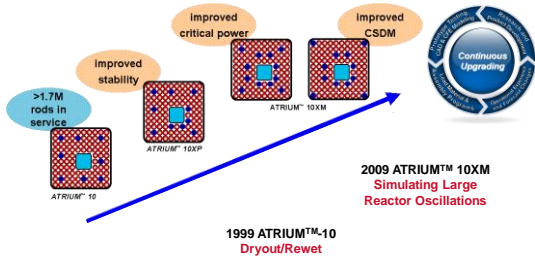
- ◆ Need to quantify performance improvements
- ◆ Need to acquire quality data to support methods development and qualification

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HISTORY of AREVA Stability Testing



1992 ATRIUM™-9

Design Configurations

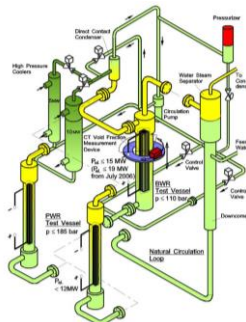
- Noise measurements
- Small amplitude oscillations

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KATHY Loop Natural Circulation for Stability Testing



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Stability Testing Scope for ATRIUM 10XM Simulating Reactor Conditions

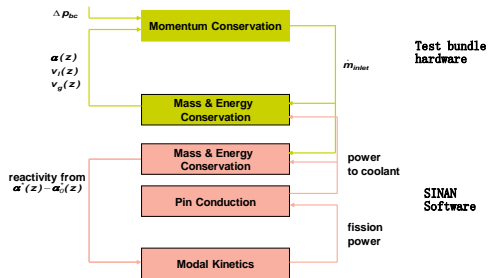
- **More realistic BWR conditions**
 - ◆ Pure hydraulic instability requires high power to excite, thus limits oscillation amplitude prior to dryout
 - ◆ Power feedback using the new SINAN software simulates reactor conditions
 - Power feedback lowers stability power threshold
 - Large magnitude flow and power oscillations made possible
- **Observed stable and growing power/flow oscillations in both the global and regional modes**
- **New experimental observations**
 - ◆ Fill a recognized need for data
 - ◆ Cyclical dryout and rewetting persist for high oscillation amplitudes
 - ◆ Failure to rewet occurs at very high oscillation amplitudes
 - ◆ Highly nonlinear oscillatory behavior and limit cycles with inlet flow reversal

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SINAN Transforms KATHY Loop to Test Reactor

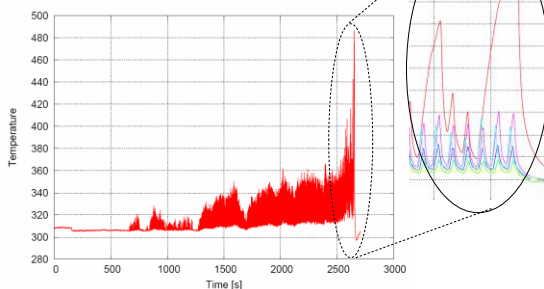


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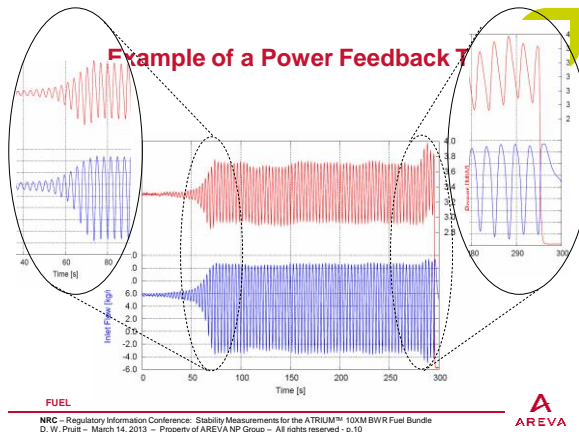
Example of a Pure Thermalhydraulic Test

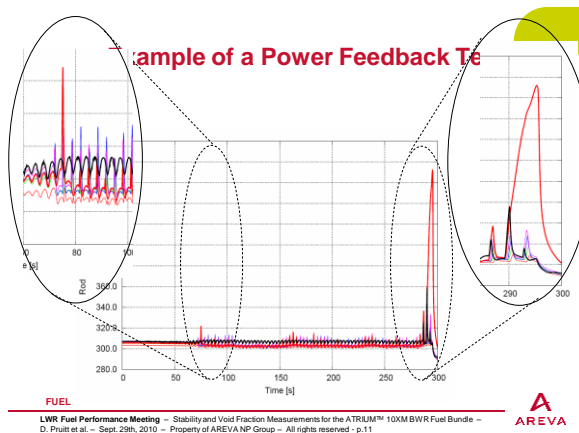


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Closing Remarks

- ▶ The ATRIUM-10XM test program surpassed previous testing in scope and findings
- ▶ Stability Testing
 - ◆ Pure thermalhydraulic testing for continuity with previous practice; additionally
 - ◆ Closed feedback loop better simulates BWR conditions
 - ◆ Extensive data on very large oscillations including large inlet flow reversal
 - ◆ Cyclical dryout/rewetting data
- ▶ These unique measurements extend the excellent validation basis of AREVA's methodologies and strongly enhance the knowledge supporting the development of new fuel designs e.g. ATRIUM™-11

Thank You



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